DOCUMENT RESUME

ED 244 588 IR 011 109

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TITLE Academic Computing as Technological Innovation.
INSTITUTION Pennsylvania State Univ., University Park. Center for the Study of Higher Education.
PUB DATE Apr 84
NOTE 21p.; Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 23-27, 1984).
PUB TYPE Information Analyses (070) -- Viewpoints (120) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Adoption (Ideas); *Computer Oriented Programs; Higher Education; *Instructional Innovation; Literature Reviews; *Organizational Change; *Organizational Theories; Research Reports; Systems Analysis; *Technological Advancement
IDENTIFIERS Academic Computing; *Computer Uses in Education

ABSTRACT

Because there is little theoretical background to explain the process of adopting computers for instruction in postsecondary institutions, this paper reviews the literature on this process from the perspective of technological innovation. Technological innovation is defined as the use of tools and techniques which extend human capability and which are new to an organization. The literature on academic computing, which consists primarily of descriptions of programs on individual campuses, is briefly reviewed. Key concepts and findings from studies on technological innovation are then outlined, providing information on the role of individuals in organizational innovation, characteristics of innovative organizations, the influence of an organization's context on the process of innovation, and the innovation process itself. The concepts found in the literature on technological innovation are applied to academic computing; evidence is cited which indicates that the perspective of technological innovation can be used to explain the process of implementing academic computing. Finally the paper suggests an agenda for further research in this area. A 22-item bibliography is provided. (Author/ESR)

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ACADEMIC COMPUTING AS TECHNOLOGICAL INNOVATION

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Paper Presented at the American Educational Research Association
New Orleans, LA
April, 1984

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Abstract

The available literature on academic computing consists primarily of descriptions of programs on individual campuses. There is little theoretical background to explain the process of implementing new approaches to academic computing. The paper uses the perspective of technological innovation to examine this topic. There is a large body of research on technological innovation--the tools or techniques which extend human capability and which are new to an organization. Because academic computing occurs in an organizational context, the paper focuses on the innovation literature which discusses organizational variables. In the available literature on academic computing, the paper finds evidence that the perspective of technological innovation explains the process of implementing academic computing.

Postsecondary education is in the midst of what Robert Gillespie calls an "accidental revolution," the mushrooming and largely unplanned use of computers on the college and university campus. Most of the current literature on computing describes the process and pitfalls of implementing computer-oriented programs from the perspective of individual campuses. Few widely applicable solutions to common problems are available. The literature focuses on surface level issues and descriptions. Unfortunately there is only limited theoretical research into the process of computerization.

This paper applies the theoretical framework of technological innovation to the process of adopting computers for instruction in postsecondary institutions. The conclusions drawn from this perspective increase the understanding of the process of computerization, highlight the implications of computerization, and provide practical suggestions for campuses in the process of the accidental revolution. First the paper briefly reviews the available literature on academic computing. Second it outlines several key concepts and findings from studies on technological innovation. Third it applies the concepts found in the literature on technolgical innovation to academic computing. This illustrates the usefulness of this theoretical approach. Finally the paper suggests an agenda for further research on academic computing which arises from the perspective of technological innovation. The issues raised in the paper deserve careful empirical investigation.

I. Academic Computing

Colleges and universities use computers for a wide variety of tasks. This paper examines one area of use--academic computing or using computers for instruction. While colleges and universities have used computing for instruction for several decades, the subject has received increased attention

recently because of the proliferation of microcomputers. Instructional computing includes activities as diverse as teaching with a computer (Computer Aided Instruction), simulation, data analysis, programming, and text processing. There are three basic approaches to academic computing in the literature. First are surveys which report the extent of academic computing and basic statistics related to its use. Second are position statements on the value of and need for academic computing. Third, and most common, are descriptions of how campuses manage and use academic computing.

Hamblen and Landis (1980) illustrates the survey approach in the academic computing literature. It summarizes the findings from a survey of computing in higher education conducted in 1976-1977. Analysis of the survey data provides information on the number of computers on campuses, the personnel supporting them, sources and uses of resources to fund computing, programs in computer science, and so forth. This information is useful in establishing levels of activity and serves as a guide for comparison by individual campuses. But it is not very useful for the campus leader who wants to implement an academic computer program or for the researcher who wants to understand the proliferation and use of academic computing. Furthermore, rapid advances in computer technology and increasing interest in broad-based computer applications makes even the most recent surveys out of date.

Two national commissions on academic computing exemplify the position statement approach to computing in the literature. The President's Science Advisory Committee (1967) describes the many academic uses of computing and states the national need for computer-oriented programs on college and university campuses. For example, it suggests an appropriate level of computer use for undergraduates of about 30 hours per year. More recently, Gillespie and Dicaro (1981) report that colleges and universities still spend only about

one-third as much per student per year on computing as the President's Science Advisory Committee suggested in 1967. Gillespie and Dicaro also identify priorities and set goals for academic computing in the years ahead. But this does not aid campus leaders who must implement computer-oriented programs or explain what factors contribute to successful implementation of computer programs on the college or university campus.

The May, 1983 issues of The Forum for Liberal Education illustrates the descriptive case study approach to academic computing. The issue describes in depth how six colleges introduced or expanded their use of computers. The issue describes the efforts of another eleven colleges in slightly less detail. The Chronicle of Higher Education is another source of descriptions of computer initiatives at colleges and universities. Magarrell (1982), for example, describes how nine institutions planned to integrate computing with the liberal arts. These descriptions are useful to campus leaders who are uncertain of how to approach computing or need to determine what strategy is most appropriate for their campus. But it is difficult to distill the important elements of computer-related programs from a large number of case studies. The readers may not know, for example, which approaches work well and what elements of the institutional setting may influence the success of a particular program. Masland (1982, 1983b) provides a preliminary analysis of several factors that influence academic computing at five colleges. The cases illustrate the influence of organizational variables on the development of academic computer programs. The discussion of computing as technological innovation in this paper uses these findings to illustrate the relationship between computing and technological innovation.

Another approach in the descriptive literature examines institutions which are acknowledged leaders or have particularly effective computer-

oriented programs. Campus Computing Strategies (McCredie, 1983) and Computers on Campus: Working Papers (Tucker, 1984) illustrate this approach. Both describe efforts at institutions such as Carnegie-Mellon University, Pepperdine University, and Stanford University. These cases are more helpful than some of the others because they include detailed descriptions of the planning and implementation process on each campus. The reader is still hampered, however, by a lack of analysis of the most important elements in each case study. It would be difficult for the reader to determine what elements of the successful programs might operate on his or her campus.

Thus campus leaders interested in implementing or expanding academic computing on their own campuses can gain a sense of how other campuses approach computing through the surveys. They can assess their institution in light of recognized national goals for computing. And they have a large number of models to choose from because the cases provide excellent examples. It is difficult, however, to determine which factors influence the spread of academic computing and why some campuses are more successful than others. The next section of the paper introduces the concept of technological innovation as a possible theoretical approach to academic computing.

II. Technological Innovation

The literature on technological innovation is vast. A 1975 review of the literature identified 2,000 items on organizational innovation and a review of technological innovation in 1978 listed over 4,000 items (Kimberly & Evanizko, 1981). The literature includes work in fields as diverse as economics, engineering, organizational behavior, and rural sociology. A recent National Science Foundation (NSF) publication, however, reviews and distills the literature, codifies definitions, and clarifies theoretical constructs

(Tornatzky, Eveland, Boylan, Hetzner, Johnson, Roitman, & Schneider, 1983). The NSF document provides the conceptual framework for this paper.

A clear definition of technological innovation is important because it has a precise meaning. Technology is "any tool or technique, or any physical method of doing or making, by which human capability is extended" (Schon, 1967). This definition encompasses both physical objects and understanding how to use them. Computer hardware, software, and, perhaps most importantly, the knowledge needed to apply computing to instruction are all technologies. The knowledge dimension of academic computer use is a technology which is often ignored.

Innovation also has a precise definition. An innovation is a technology which is new to a given organization (Tornatzky et al., 1983). There is a distinction between knowledge of a technology and the active consideration of it. The latter, not the former, constitutes the innovation. Thus many institutions may be aware of academic computing, its importance, and its potential, but academic computing is not an innovation at a particular institution until that campus takes active steps to use the technology. Furthermore, once an organization routinizes a technology it is no longer an innovation.

Because the literature on technological innovation is so vast, this paper focuses on several elements in it. Unfourtunately, this approach slights other important traditions within the field of innovation. One is the literature on diffusion of innovation. This literature, summarized by Rogers (1961) and more recently by Rogers and Shoemaker (1971), views innovation from an individual perspective. Rogers and Shoemaker (1971) define an innovation as an idea, practice, or object perceived as new by an individual who is a member of a social system. The diffusion literature studies the spread of innovations through a social system. Part of this literature investigates the

characteristics of individuals who are more likely to adopt innovative technologies. Another element of the diffusion literature uses mathematical formulations to describe the spread of innovations (Tornatzky et al., 1983). But while such descriptions model the innovation process quite well, they do not explain it.

Academic computing occurs within an institutional context, so the literature on technological innovation that focus on organizational issues is a more useful perspective. This paper examines literature which discusses organizational characteristics such as roles, structure, size, complexity, and external context (Corwin, 1972; Tornatzky et al., 1983). The paper also reviews and applies the literature on the process of adopting innovations. While some of the literature on technological innovation treats adoption as a one-time decision, it is now clear that innovation is a process that occurs over time and involves more than one simple decision.

Organizational Roles. Although innovation occurs within an organization, individuals still play an important role in the innovation process. One tradition in the literature identifies individual characteristics that relate to innovative behavior. In summarizing the literature, Rogers and Shoemaker (1971) identify 32 generalizations about individuals who are more likely to innovate. Among the characteristics which describe innovators are higher social status, more favorable attitudes towards credit, risk, education, and science, greater intelligence, more exposure to mass media and interpersonal communications channels, more cosmopolitan backgrounds, more information and knowledge about innovations, and greater social participation. As Tornatzky et al. (1983) point out, however, the studies that Rogers and Shoemaker draw upon, suffer from methodological problems which limit the

validity of their findings. This literature also relies upon the trait-style conception of psychology which no longer enjoys wide currency.

More recently, researchers have examined the roles that individuals hold rather than their personal characteristics. The concept of role identifies the "position individuals have relative to other people in an interpersonal system and the expectations about their behavior held by others" (Tornatzky et al., 1983, p. 100). This approach is quite useful in explaining innovation. Corwin (1972), Counte and Kimberly (1974), and Baldridge and Burnham (1975), for example, report that the presence and strength of several roles within an organization relates to innovative behavior while individual characteristics are poor predictors of organizational innovation.

Among the roles that support innovation are those which enhance communication among members of the organization and bewteen the organization and its external environment. Baldridge & Brunham (1975) discuss the "boundary" role which links the organization to the demands and ideas external to it. The term "gatekeeper" also describes this type of role behavior. The individual in this role is an important source of technical information for the organization. The gatekeeper "absorbs complex technical information and translates it into a more understandable form for co-workers and top management" (Tornatzky et al., 1983, p. 106). Another role is a "product champion" who nurtures an innovative idea until it can survive on its own. A product champion also sells an innovation to top management, is intensely interested in it, and plays a dominant role in the implementation process (Chakrabarti, 1974). For example, he or she helps the organization cope with obstacles or problems encountered in the process of adopting the innovation. The qualities of a product champion includes technical competence, knowledge about the organization, understanding the potential usefulness of the

innovation, political astuteness, and a direct and agressive nature (Chakrabarti, 1974).

External to the organization, but in a role somewhat similar to the product champion or gatekeeper, is a change agent who provides the organization with information about an innovation (Rogers & Shoemaker, 1971). Counte and Kimberly (1974) found that in a professional setting the presence of a change agent such as a consultant explains about two-thirds of the variance in innovative behavior. There is evidence, however, that a change agent is less important for social innovations which do not involve material changes such as new tools (Berg & Ostergren, 1977).

Organizational Characteristics. Another element of the literature on technological innovation focuses on characteristics of innovative organizations. Burns and Stalker (1961), for example, describe organizations as either "organic" or "mechanistic". They report that "organic" organizations, which are less bureaucratic than "mechanistic" organizations, tend to be more innovative. Subsequent research is somewhat more sophisticated in its description of organizational characteristics and thus is more helpful. Common characteristics the literature discusses are size, centralization, and formalization. Studies generally report that increasing size and decreasing formalization stimulate innovation. Centralization may increase innovation through improved communication and leadership, but it can also decrease innovation if organizational leaders are not innovative (Hage & Aiken, 1967; Baldridge & Burnham, 1975; Moch & Morse, 1977; Kimberly & Evanisko, 1981; Tornatzky et al, 1983).

Size, centralization, and formalization may actually be proxy variables for a number of other organizational characteristics. Size, for example, may

measure organizational complexity and the diversity of specialization within the organization. As organizations become more complex, there is more opportunity for innovations which solve specialized problems efficiently. Similar problems may not be large enough to warrant innovative behavior in smaller organizations or a small organization may not be aware of innovative practices. It is also possible that larger organizations are more innovative because they need innovative techniques to solve the problems of control and administration associated with increased size or because they have greater resources to support innovation (Baldridge & Burnham, 1975). Centralization may also be a measure of specialization within the organization. More specialized organizations have greater opportunities to apply innovations in well defined areas and the specialists may have a greater knowledge of their particular area and new technologies they could apply within it (Moch & Morse, 1977).

Organizational Context. The organizational literature also examines the influence of the organization's context on the process of innovation. A rapidly changing environment or a clientele which demands diverse services may lead to innovative behavior as the organization tries to meet the demands of its environment. The effects of context, however, are less clear than those of roles and organizational characteristics. Corwin (1972), Counte and Kimberly (1974), and Kimberly and Evanisko (1981) all report that contextual factors influence innovation. In a hospital setting, for example, competition from other medical centers, the age of the building, and the size of the local population affect the rate of technical innovation (Kimberly & Evaniski, 1981). Aiken and Hage (1968) found that organizations which have more extensive cooperative and interdependent relationships with other organizations are also more innovative. Baldridge and Burnham (1975) stated, however, that

contextual factors are not significantly related to innovation. Thus contextual factors may influence organizational innovation, but the evidence is not as clear as that which supports the importance of roles and organizational characteristics.

The Process of Innovation. In an organizational setting a simple decision to adopt a new technology cannot explain innovation. Innovation is a process and not a choice. A decision to adopt an innovation does not mean that the organization will complete the adoption process, that the entire organization will adopt it, or do so at a single point in time. The innovation may become a political issue. While an innovation's core technology will likely remain essentially unchanged, the superfluous elements may change and adapt to the organization's needs (Berg & Ostergren, 1977; Tornatzky et al, 1983).

Berg and Ostergren (1977) use Lewin's description of implementation to explain the process of innovation in universities. They report that universities move through Lewin's stages of unfreezing, moving, and refreezing during innovative activities. In the unfreezing stage an organization realizes the need for change and innovation. In the second stage of moving it makes the innovative changes. In the third stage of refreezing, the changes become a permanent part of the organization. Thus organizations move along an implementation continuum. An early decision to adopt an innovation, preceeds a period of changing the innovation to meet organizational requirements or perhaps adapting the organization to the innovation. Finally the innovation becomes a permanent part of the organization, at which point it is no longer an innovation. An organization may also find that an innovation is not useful or efficient and return to former practice.

It may be that the inconsistent findings about organizational influences on the innovation process result from studying organizations which are at different points along the continuum of adoption and implementation. During the unfreezing stage contextual factors may help the organization see the need for innovation while structural characteristics may influence the ease of actually using the innovation. Whatever the case may be, it is important to note that adoption of innovation is a complex process that occurs over time and that can involve many parts of the organization.

III. Applying Technological Innovation to Academic Computing

The concept of technological innovation and the interaction between innovation and the organizational variables described above are readily applicable to academic computing. The following section examines academic computing from the perspective of technological innovation. It also uses research on administrative computing when the evidence on the interaction of academic computing and innovative behavior is scarce.

Organizational Roles. In five case studies Masland (1982, 1983b) reports individuals in roles similar to those described in the innovation literature. The individual who supports the adoption of academic computing may be a product champion who nurtures computing on the campus before it becomes popular and widely accepted. Or the individual may be a gatekeeper who understands the technical aspects of computing and translates jargon into language colleagues and students can understand. The individuals who fulfill the roles have diverse characteristics and they come from many departments and disciplines. There is no consistent pattern in who fills the roles on the campus, but the case studies indicate that the presence of the roles positively influences implementation of new computer-oriented programs.

Welsch (1981) and Masland (1984) apply the concept of roles to innovative administrative computing practices. Both report that the successful implementation of Decision Support Systems (sophisticated computer-based information and modeling systems that administrators use for semi-structured decisions) is related to the active presence of certain organizational roles. Specifically, both studies report that individuals within an organization who can facilitate the use of an innovation and provide technical assistance to those who are not familiar with it enhance the success of innovations. Furthermore Masland (1984) found greater success with the innovation if the individual in the role was internal to the organization rather than external.

Organizational Characteristics. The importance of size, centralization, and formalization also appears in the descriptive literature on academic computing. Davis and Emery (1978), for example, note that small colleges generally have more difficulty with innovative academic computing programs than larger institutions. Small institutions often lack the resources and specialization of larger institutions. Carnigie-Mellon University, Brown University, and the Massachusetts Institute of Technology are three institutions which are participating in major programs to develop new approaches to hardware, software, and academic applications of computing. These acknowledged leaders in innovative academic computing are large complex institutions which have attracted sufficient resources to support innovative projects. Each institution also has specialized professionals who understand the technology and can explore new and alternate applications of it on the university campus (Tucker, 1984).

While the evidence is not conclusive, it appears that a lack of formalization relates to higher levels of innovation. Masland (1982, 1983b) suggests that communication among faculty, students, and administrators improves the success of innovative academic computing programs at some small colleges. When faculty members and students are aware of how others on their campus use academic computing, they are likely to adopt such uses themselves. In these cases the lack of formalization overcomes the small size. It is important to note, however, that the less formalized small colleges Masland discusses were relatively late in adopting academic computing and their size was a critical factor in delaying their implementation of academic computing.

Organizational Context. As with organizational roles and characteristics, the descriptive literature generally acknowledges the importance of contextual variables in stimulating academic computing. This element is also evident in position statements on academic computing such as Gillespie and Dicaro's (1981). The factors in the context include students who demand academic computing programs and facilities. Colleges and universities realize the importance of computing programs when they compete for these students. Another factor is an external pressure from students and employers who realize the value of computing skills and knowledge. Many campuses acknowledge that needs such as these are prime factors in stimulating innovation in academic computing. A description of Rollins College's computer literacy program, for example, notes that learning computer skills reduces students' anxiety upon entering the work force because it improves their qualifications (The Forum for Liberal Education, 1983).

The Process of Innovation. By their very nature the case descriptions generally acknowledge the process of implementing innovative computing programs. A case will often give detailed accounts of implementing an academic computing initiative. This is usually done informally, however, with little attention given to the actual steps involved, the problems encountered, and solutions to these problems which would be appropriate for other institutions. The cases frequently give the reader little more than detailed information about a particular approach. In addition the cases often depict an institution which has only partially completed the implementation process. The reader does not know if the institution eventually completed the process or modified its plans after the case was written. There are several exceptions, however. The description of Pepperdine University's planning process (McCredie, 1983) is quite detailed. Tucker (1984) excerpts key documents from the planning process at Carnegie-Mellon University. These cases illustrate institutions which have recognized the need for change (unfreezing) and have begun the moving phase of implementation.

The literature on administrative computing is slightly more sophisticated in reporting on implementation problems. Lists of factors that affect the implementation process are commonly found in descriptive studies of administrative computing (Masland, 1983a). Welsch (1981) and Masland (1984) also successfully apply Lewin's stages of unfreezing, moving, and refreezing to administrative computing. This explicit application is generally missing in the literature on academic computing.

Thus the available literature on academic computing reflects the concepts and variables the literature on technological innovation describes. While this perspective is not explicitly taken, in retrospect it explains the findings and discussions.

IV. Conclusion

The literature on academic computing generally lacks any theoretical or conceptual support. Most articles and papers describe innovation efforts at one institution or argue for the need for increased innovation in the area of academic computing. This situation may have arisen because most institutions are struggling to implement academic computing and may not have the time to study their own efforts or those of other institutions. While the descriptive literature is of assistance to those who want to learn how institutions approach the common problems of academic computing, it does not identify the critical elements that may determine the success of implementation efforts.

Studying academic computing as technological innovation is one of many possible theoretical approaches. As this paper describes, the literature identifies organizational factors such as roles, size, formalization, and context which affect innovation. This approach stresses the organizational aspects of academic computing. Examining the problem from the perspective of the individual faculty member or student through the diffusion literature is another obvious approach to academic computing. This perspective might tell us more about the spread of computing within an individual campus.

The application of the organizational approach has several implications for institutions considering implementing new programs or practices for academic computing. First is consideration of roles, characteristics, and context. Organizational characteristics such as formalization are resistant to change and changing them would be innovation itself. The context is also difficult if not impossible to change. Yet the institution that is aware of the influence of these factors can take them into consideration. Organizational roles are more likely to be ammenable to change. Before initiating a new

program in academic computing, an institution might consider if there is an individual or group who can fulfill the roles which are associated with successful innovation. If the roles are not filled on the campus, the institution might seek an external change agent who can assist with the innovation process.

Considering the broad definition of technology this paper uses, institutions might also consider the social and conceptual changes evident in new computing projects. Academic computing as innovation means more than new computer hardware. It also refers to the way in which the hardware is used, how it affects teacher-student interactions, and how it may change the curriculum. Colleges and universities that do not consider the broader implications of innovative practices may be surprised at the results of their programs or not be as successful as would be possible otherwise.

Finally the perspective of technological innovation provides a theoretical foundation which is currently lacking in the literature on academic computing. If computing revolutionizes higher education, as some authorities believe it will, it is important that it is properly understood. Examining how innovation affects the teaching environment and curriculum, for example, may change expectations about computing or the way in which institutions approach academic computing. An endeavor which demands the financial resources, time, and effort of colleges and universities deserves closer examination and study. Empirical studies of innovative academic computing programs can build from the evidence presented here to test the relative importance of the organizational factors. The perspective of technological innovation is one approach which appears useful and which deserves further attention.

REFERENCES

Aiken, M. & Hage, J. Organizational interdependence and intra-organizational structure. American Sociological Review, 1968, 33, pp. 912-930.

Baldridge, J. V. & Burnham, R. A. Organizational innovation: individual, organizational, and environmental impacts. Administrative Science Quarterly, 1975, 20, pp. 165-176.

Berg, O. & Ostergren, B. Innovations and Innovation Process in Higher Education. Stockholm: National Board of Universities and Colleges, 1977.

Burns, T. & Stalker, G. M. The Management of Innovation. Chicago, Illinois: Quadrangle Books, 1961.

Chakrabarti, A. K. The role of champion in product innovation. California Management Review, 1974, 17(2), pp. 58-62.

Corwin, R. G. Strategies for organizational innovation: an empirical comparison. American Sociological Review, 1972, 37, pp. 441-454.

Counte, M. A. & Kimberly, J. R. Organizational innovation in a professionally dominated system: responses of physicians to a new program in medical education. Journal of Health and Social Behavior, 1974, 15, pp. 188-198.

Davis, D. L. & Emery, J. C. Computing for the liberal arts college. EDUCOM Bulletin, Winter 1978, pp. 16-22.

Forum for Liberal Education, 5(5), May/June 1983.

Hage, J. & Aiken, M. Program change and organizational properties: a comparative analysis. American Journal of Sociology, 1967, 72, pp. 503-519.

Hamblen, J. W. & Landis, C. P. (Eds.). The Fourth Inventory of Computers in Higher Education: An Interpretive Report. Boulder, Colorado: Westview Press, 1980.

Kimberly, J. R. & Evanisko, M. J. Organizational innovation: the influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations. Academy of Management Journal, 1981, 24, pp. 689-713.

Masland, A. T. Organizational influences on computing in higher education. Doctoral dissertation, Harvard University, 1982.

Masland, A. T. Simulators, myth, and ritual in higher education. Research in Higher Education, 1983a, 18, pp. 161-178.

Masland, A. T. The integrator role in academic computing. Paper presented at the 1983 Association for Institutional Research Forum, 1983b. (ERIC Document Reproduction Service No. ED 232 599)

Masland, A. T. Integrators and decision support system success in higher education. Research in Higher Education, 1984, 20(2).

McCredie, J. W. (Ed.) Campus Computing Strategies. Bedford, Massachusetts: Digital Press, 1983.

Rogers, E. M. Diffusion of Innovations. New York, NY: Free Press, 1962.

Rogers, E. M. with Shoemaker, E. F. Communication of Innovations. New York, New York: The Free Press, 1971.

Schon, D. A. Technology and Change. New York, New York: Delacorte Press, 1967.

Tornatzky, L. G., Eveland, J. D. Boylan, M. G., Hetzner, W. A., Johnson, E. C., Roitman, D., & Schneider, J. The Process of Technological Innovation: Reviewing the Literature. Washington, DC: National Science Foundation, 1983.

Tucker, M. S. Computers on campus: working papers. Current Issues in Higher Education, 1984, Number 2.